

CLAIMS

1           We claim:

2        1. A spray head comprising:

3                 a plurality of fluidic oscillators, each oscillator having a body member with  
4                 top, bottom, side, front and rear outer surfaces, each oscillator having a fluidic circuit  
5                 embedded in said top surface, said circuit forming a path in which a fluid may flow  
6                 through said oscillator, each said fluidic circuit having a fluid inlet, a power nozzle,  
7                 an interaction chamber and an outlet in said front surface from which a fluid may exit  
8                 said oscillator,

9                 wherein said oscillators being stacked one on top of the other,

10                wherein said body member being configured so that said oscillators stack such  
11                that the flow of fluid from adjoining oscillators in said stack have an angle of  
12                divergence between the centerlines of the planes defined by the flows from the outlets  
13                of said adjoining oscillators.

14        2. A spray head as recited in claim 1 further comprising a plurality of cover plates,  
15                wherein each said cover plate is configured, and is proximate the top surface of one of  
16                said fluidic oscillators, and is attached to said oscillator so as to provide a seal against  
17                the leakage of fluid from the top surface of said oscillator.

18        3. A spray head as recited in claim 2 further comprising a carrier assembly having a  
19                front and a rear surface and a cavity extending between said assembly surfaces,  
20                wherein said cavity configured so to receive and hold said stack of fluidic oscillators.

21        4. A spray head as recited in claim 3 further comprising a stopper unit that attaches to  
22                the rear surface of said assembly so as to provide a seal against the leakage of fluid  
23                from said assembly rear surface.

24        5. A spray head as recited in claim 1 wherein said angle of divergence is in the range  
25                of 2 – 5 degrees.

26        6. A spray head as recited in claim 2 wherein said angle of divergence is in the range  
27                of 2 – 5 degrees.

28        7. A spray head as recited in claim 3 wherein said angle of divergence is in the range  
29                of 2 – 5 degrees.

1       8. A method of forming a fluid spray whose droplets cover a specified surface area  
2       having a prescribed width and height, said area located at a prescribed distance in  
3       front of a spray head emitting said fluid spray, said method comprising the steps of:

4                 stacking a plurality of fluidic oscillators one on top of the other, each  
5       oscillator having a body member with top, bottom, side, front and rear outer surfaces,  
6       each oscillator having a fluidic circuit embedded in said top surface, said circuit  
7       forming a path in which a fluid may flow through said oscillator, each said fluidic  
8       circuit having a fluid inlet, a power nozzle, an interaction chamber and an outlet  
9       having a prescribed fan angle in said front surface from which a fluid may exit said  
10      oscillator,

11                 configuring said body members of said oscillator stack such that the flow of  
12       fluid from adjoining oscillators in said stack have a specified angle of divergence  
13       between the centerlines of the planes defined by the flows from the outlets of said  
14       adjoining oscillators,

15                 selecting said fan angles of said oscillators so as to yield said prescribed spray  
16       width,

17                 selecting said specified angle of divergence and the number of said fluidic  
18       oscillators in said stack so as to yield said prescribed spray height.

19       9. A method as recited in claim 8 further comprising the step of providing a plurality  
20       of cover plates, wherein each said cover plate is configured, and is proximate the top  
21       surface of one of said fluidic oscillators, and is attached to said oscillator so as to  
22       provide a seal against the leakage of fluid from the top surface of said oscillator.

23       10. A method as recited in claim 9 further comprising the step of providing a carrier  
24       assembly having a front and a rear surface and a cavity extending between said  
25       assembly surfaces, wherein said cavity configured so to receive and hold said stack of  
26       fluidic oscillators.

27       11. A method as recited in claim 8 wherein said angle of divergence is in the range of  
28       2 – 5 degrees.

29       12. A method as recited in claim 9 wherein said angle of divergence is in the range of  
30       2 – 5 degrees.

1       13. A method as recited in claim 10 wherein said angle of divergence is in the range  
2       of 2 – 5 degrees.

3       14. A method of providing a fluid spray at a flow rate in the range of approximately  
4       1.2 – 1.9 gpm that yields massaging, tactile sensations, as the droplets of said spray  
5       impact upon the skin of one in the line of flight of said spray, which are comparable  
6       to those produced by non-fluidic, generated sprays operating in the range of  
7       approximately 2.0 - 2.5 gpm, said method comprising the steps of:

8              stacking a plurality of fluidic oscillators one on top of the other, each  
9       oscillator having a body member with top, bottom, side, front and rear outer surfaces,  
10      each oscillator having a fluidic circuit embedded in said top surface, said circuit  
11      forming a path in which a fluid may flow through said oscillator, each said fluidic  
12      circuit having a fluid inlet, a power nozzle, an interaction chamber and an outlet in  
13      said front surface from which a fluid may exit said oscillator, said circuit emitting an  
14      effective string of fluid droplets that are swept from side-to-side at a prescribed  
15      frequency which is dependent upon said circuit geometry,

16              configuring said body members of said oscillator stack such that the flow of  
17      fluid from adjoining oscillators in said stack have a specified angle of divergence  
18      between the centerlines of the planes defined by the flows from the outlets of said  
19      adjoining oscillators,

20              selecting said prescribed frequencies of said oscillators to be in the range  
21      between 10 cps and 60 cps.

22       15. A method as recited in claim 14 further comprising the step of providing a  
23      plurality of cover plates, wherein each said cover plate is configured, and is  
24      proximate the top surface of one of said fluidic oscillators, and is attached to said  
25      oscillator so as to provide a seal against the leakage of fluid from the top surface of  
26      said oscillators.

27       16. A method as recited in claim 15 further comprising the step of providing a carrier  
28      assembly having a front and a rear surface and a cavity extending between said  
29      assembly surfaces, wherein said cavity configured so to receive and hold said stack of  
30      fluidic oscillators.

1       17. A method as recited in claim 14 wherein said angle of divergence is in the range  
2       of 2 – 5 degrees.

3       18. A method as recited in claim 15 wherein said angle of divergence is in the range  
4       of 2 – 5 degrees.

5       19. A method as recited in claim 16 wherein said angle of divergence is in the range  
6       of 2 – 5 degrees.

7       20. A method of providing a fluid spray at a flow rate in the range of approximately  
8       1.2 – 1.9 gpm that yields massaging, tactile sensations, as the droplets of said spray  
9       impact upon the skin of one in the line of flight of said spray, which are comparable  
10      to those produced by non-fluidic generated sprays operating in the range of  
11      approximately 2.0 - 2.5 gpm, said method comprising the steps of:

12           using a fluidic oscillator to generate said spray,

13           wherein said fluidic oscillator configured so as to provide a spray which  
14      exhibits an oscillation frequency in the range of 10 - 60 cps.

15       21. A method of providing a fluid spray that yields massaging, tactile sensations, as  
16       the droplets of said spray impact upon the skin of one in the line of flight of said  
17       spray, said method comprising the steps of:

18           using a fluidic oscillator to generate said spray,

19           wherein said fluidic oscillator configured so as to provide a spray which  
20      exhibits an oscillation frequency in the range of 10 - 60 cps.

21       22. A method of providing a fluid spray at a specified flow rate that feels, as the  
22       droplets of said spray impact upon the skin of a bather in the line of flight of said  
23       spray, to a bather using said spray that said spray is being delivered at a higher flow  
24       rate than said specified flow rate at which said spray is being operated, said method  
25       comprising the steps of:

26           using a fluidic oscillator to generate said spray,

27           wherein said fluidic oscillator configured so as to provide a spray which  
28      exhibits an oscillation frequency of greater than 60 cps.

29       23. A method of providing a multi-functional spray head, said method comprising  
30      the steps of:

1               stacking a plurality of fluidic oscillators one on top of the other, each  
2       oscillator having a body member with top, bottom, side, front and rear outer surfaces,  
3       each oscillator having a fluidic circuit embedded in said top surface, said circuit  
4       forming a path in which a fluid may flow through said oscillator, each said fluidic  
5       circuit having a fluid inlet, a power nozzle, an interaction chamber and an outlet  
6       having a prescribed fan angle in said front surface from which a fluid may exit said  
7       oscillator,

8               configuring said body members of said oscillator stack such that the flow of  
9       fluid from adjoining oscillators in said stack have a specified angle of divergence  
10      between the centerlines of the planes defined by the flows from the outlets of said  
11      adjoining oscillators,

12               surrounding said stack of fluidic oscillators with a plurality of orifices that  
13       emit fluid sprays formed by other than the use of fluidic oscillators.

14       **24. A spray head comprising:**

15               a plurality of fluidic oscillators, each oscillator having a body member with  
16       top, bottom, side, front and rear outer surfaces, each oscillator having a fluidic circuit  
17       embedded in said top surface, said circuit forming a path in which a fluid may flow  
18       through said oscillator, each said fluidic circuit having a fluid inlet, a power nozzle,  
19       an interaction chamber and an outlet in said front surface from which a fluid may exit  
20       said oscillator,

21               a carrier assembly having a front and a rear surface and a plurality of slots  
22       which are aligned one above the other with each slot extending between said  
23       assembly surfaces, wherein each of said slots configured so to receive and hold one of  
24       said fluidic oscillators, wherein each of said slots having a centerline,

25               wherein said carrier assembly being further configured so that said slot  
26       centerlines align such that the flow of fluid from adjoining oscillators in said slots  
27       have an angle of divergence between the centerlines of the planes defined by the  
28       flows from the outlets of said adjoining oscillators.

29       **25. A spray head as recited in claim 24 wherein said angle of divergence is in the**  
30       range of 2 – 5 degrees.

31       **26. A method of forming a fluid spray comprising the steps of:**

1               assembling a plurality of fluidic oscillators, each oscillator having a body  
2 member with top, bottom, side, front and rear outer surfaces, each oscillator having a  
3 fluidic circuit embedded in said top surface, said circuit forming a path in which a  
4 fluid may flow through said oscillator, each said fluidic circuit having a fluid inlet, a  
5 power nozzle, an interaction chamber and an outlet in said front surface from which a  
6 fluid may exit said oscillator,

7               fabricating a carrier assembly having a front and a rear surface and a plurality  
8 of slots which are aligned one above the other with each slot extending between said  
9 assembly surfaces, wherein each of said slots configured so to receive and hold one of  
10 said fluidic oscillators, wherein each of said slots having a centerline,

11               wherein said carrier assembly being further configured so that said slot  
12 centerlines align such that the flow of fluid from adjoining oscillators in said slots  
13 have an angle of divergence between the centerlines of the planes defined by the  
14 flows from the outlets of said adjoining oscillators.

15               27. A method as recited in claim 26 wherein said angle of divergence is in the range  
16 of 2 – 5 degrees.

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